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LIPIDS AND FATTY ACID COMPOSITION OF DEVELOPING WINGED BEAN SEEDS

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Key Word Index—*Psophocarpus tetragonolobus*; Leguminosae; winged bean; seed; lipids; fatty acid composition; development.

Abstract—The moisture, lipids and fatty acid composition of developing winged bean (*Psophocarpus tetragonolobus*) seeds were studied. The moisture content decreased steadily as the seeds matured. The lipid content increased gradually and reached a maximum *ca* 6 weeks after flowering (WAF). In the early stage (2 WAF) of the developing seeds there were more polar lipids (glycolipids and phospholipids) than neutral lipids but, as the seeds developed, neutral lipids gradually accumulated while the polar lipids decreased until 6 WAF. Thereafter, both the neutral lipid and polar lipid levels remained little changed. The amounts of palmitic and stearic acids decreased, but the level of behenic acid increased as the seeds matured. On the other hand, the oleic acid content increased while that of linolenic acid decreased rapidly as the seeds matured. The concentration of linoleic acid, however, fluctuated during the development of the seeds.

INTRODUCTION

The potential of winged bean (*Psophocarpus tetragonolobus*) seed oil as an alternative source of vegetable oil in the tropics has been recently discussed [1]. The lipid content and fatty acid composition of different varieties of winged bean seeds have been reported [2–5]. Winged bean seed oils are characterized by having a relatively high content (10–17%) of behenic acid (22:0). This acid, present in small amounts *ca* 2%, in peanut oil has been incriminated as the cause for the higher atherogenicity of the oil in laboratory animals [6–10]. In the present study, we have followed the development and accumulation of lipids as well as the fatty acid composition in developing winged bean seeds.

RESULTS AND DISCUSSION

The agronomy and botany of winged bean have been well-documented [11]. In the present study, the development and accumulation of lipids as well as the changes in fatty acid composition were followed from 2 weeks after flowering (WAF) to 8 WAF. In the first 3 WAF, the pods increased greatly in length and in the next 5 weeks, the pods increased mainly in size. By 8 WAF, the pods had shrivelled and dried up; the seeds were fully matured.

The moisture and lipid contents of the developing winged bean seeds are shown in Table 1. The moisture content was high during the first 3 WAF but gradually decreased after 3 WAF to the final content of 42% by 8 WAF. Similar changes in moisture content has been observed in developing soybean [12]. The total seed lipids, on the other hand, increased steadily from an initial 1.1% to a maximum of 12.7% by 6 WAF and, thereafter, remained at *ca* the same amount. The final concentration of lipids in the present study is comparable to earlier reports [2–5]. In soybean, the total seed lipids increase steadily and reach a maximum only at 97 days after flowering [12].

Fractionation of the total seed lipids into neutral lipid, glycolipid and phospholipid fractions by hydrochloric acid-treated CC [13] showed that at 2 WAF the seeds contained more polar lipids (glycolipids and phospholipids) than neutral lipids (Table 1). But, as the seeds developed, more and more neutral lipids were accumulated and reached a maximum of *ca* 90% by 6 WAF and, thereafter, remained roughly at the same level. Preliminary study showed that the major component of the neutral lipids was triacylglycerol and quantification of the individual neutral lipid class is in progress. The amounts of glycolipids and phospholipids, on the other hand, decreased as the seeds developed but this stabilised after 6 WAF at *ca* 2% and 6% for glycolipids and phospholipids, respectively. In developing soybean, the neutral lipid content is also reported to be lower than the

Table 1. Moisture and lipids of developing winged bean seeds (wt %)

WAF	No. of seeds	Moisture	Total lipids (% fr wt)	NL	GL	PL
2	190	79.0	1.1	40.7	19.2	40.0
3	140	81.9	2.2	63.0	13.6	19.2
4	75	74.5	5.6	78.2	7.1	8.9
5	43	63.2	8.2	87.5	2.5	7.5
6	68	54.7	12.7	90.4	2.3	6.7
7	44	54.0	10.5	89.0	2.0	6.6
8	65	41.3	11.9	90.0	2.5	6.0

WAF, Weeks after flowering; NL, neutral lipids; GL, glycolipids; PL, phospholipids.

polar lipids in the early stages (9–18 days after flowering) and at the later stages the contents of neutral lipids far exceeded that of the polar lipids [12].

Analysis of the fatty acid composition of the total seed lipids from different WAF indicated that there were marked changes in the composition of the major saturated and unsaturated fatty acids (Table 2). Palmitic acid (16:0), for example, increased during the first 3 WAF and, thereafter, decreased to a final concentration of *ca* 5%. The level of stearic acid (18:0), on the other hand, was 9% at 2 WAF and, thereafter, decreased to *ca* 3%. The level of 22:0 was initially low (*ca* 2%) and increased to a maximum of *ca* 11.5% by 5 WAF and, thereafter, remained at about the same concentration. In soybean, the initial contents of 16:0 and 18:0 were much higher [12] than those seen in developing winged bean seeds (Table 2), but the trend of changes of these two fatty acids in both the legumes was similar.

For the unsaturated fatty acids, oleic acid (18:1) increased rapidly in the first 3 WAF and peaked at 4 WAF; thereafter it decreased and levelled off after 6 WAF. Linoleic acid (18:2) also increased, but this was not consistent as its concentration fluctuated up and down during seed development. Linolenic acid (18:3), on the other hand, decreased rapidly from an initial 23% to a final concentration of *ca* 2%. High contents of 18:2 and 18:3 were also observed in developing soybean [12] but the final amount of 18:3 in soybean was higher than that of winged bean.

Table 2. Fatty acid composition of developing winged bean seeds

Fatty acids	WAF						
	2	3	4	5	6	7	8
12:0	0.1	tr	tr	tr	0.1	0.1	tr
14:0	0.2	0.1	tr	tr	tr	tr	tr
16:0	17.7	26.3	6.4	5.6	5.2	5.3	5.5
16:1	0.2	tr	0.1	tr	tr	0.1	0.2
18:0	9.1	3.7	4.2	3.3	2.6	2.6	2.7
18:1	9.5	13.0	35.3	33.9	29.5	27.8	29.5
18:2	34.5	31.8	36.7	35.7	42.3	42.7	39.9
20:0	0.6	0.4	1.1	0.7	0.7	0.7	0.8
18:3	23.5	19.3	4.3	2.5	1.3	3.2	2.7
20:1	0.4	0.7	2.1	2.9	3.2	2.5	2.8
20:2	0.2	0.1	0.2	0.3	0.4	0.5	0.4
22:0	2.2	2.9	7.7	11.5	11.2	10.7	11.6
22:1	0.5	0.4	0.3	0.6	0.8	0.7	0.7
24:0	1.1	1.3	1.6	2.8	2.7	3.0	2.9
Total saturated	31.0	34.7	20.9	23.9	22.4	22.3	23.5
Total unsaturated	68.8	65.3	79.0	76.0	77.5	77.6	76.4

WAF, Weeks after flowering; tr, trace, < 0.1%.

EXPERIMENTAL

Winged bean (*Psophocarpus tetragonolobus*) was grown in the field. The flowers were tagged as they appeared and the pods harvested at different intervals after flowering. The seeds were removed from the pods and stored below 0° in a freezer until analysis.

Lipid extraction. Frozen seeds were thawed and superficially dried with soft tissue towels. The seeds were then weighed, homogenized and extracted with 20 vols $CHCl_3$–MeOH (2:1) as described in ref. [5].

Column chromatography. Total seed lipids were fractionated into neutral, glyco- and phospholipid fractions on HCl-treated Florisil columns as described in ref. [13].

Gas chromatography. Fatty acid Me esters (FAME) of the total seed lipids were prepared as described in ref. [14] and analysed on a FID instrument and a glass column (2 m × 4 mm) packed with Chromosorb Q coated with either 12% EGSS-X or 12% EGSS-Y. The analyses were carried out isothermally at 180°. Each sample was analysed first on a 12% EGSS-X column and then on a 12% EGSS-Y column to resolve overlapping peaks as suggested in ref. [15]. Peak areas were estimated as described in ref. [16].

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